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mains for the future to show whether the pragmatic method, that of science, can be extended to the confines of human speculation, or must fail in the fields of metaphysics and philosophy.

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The Integrative Action of the Nervous System. Comprising the Silliman Memorial Lectures delivered at Yale University, 1904. CHAS. S. SHERRINGTON. New York: Chas. Scribner's Sons. 1906. Pp. xvi + 411.

The aim of this book, as its title indicates, is to set forth in detail the manner in which the nervous system serves to bring together in united action the various parts of the animal organism. There are other agencies also which bring about integration of the organism, as, for example, the mechanical union of parts by connective tissue, the union through chemical action in digestion, or through transference of fluid, as in the circulation of the blood. The integration which is the function of the nervous system, however, is unique in that 'it works through living lines of stationary cells along which it dispatches waves of physicochemical disturbance, and these act as releasing forces in distant organs where they finally impinge' (p. 3). An important characteristic of this integration, moreover, is that it is an integration of *activities.* By means of the nervous system the organism is enabled to act as a unit toward ends which the action of every part subserves.

This functional unity of the entire organism is attained through the activity of the nervous system as a coordinative mechanism. This coordination, expressed in its simplest terms, is the production of an activity which is appropriate to a given stimulus. The unit of such coordination is the reflex act, and the corresponding nervous unit is the reflex arc. The first problem which the author attacks, then, is the determination of the characteristics of simple reflex action.

The significant characteristics of reflex action are brought into relief by a comparison of conduction in the reflex arc with conduction in the nerve trunk. It is in virtue of these characteristics that the reflex arc is fitted to be a coordinative mechanism.

The differences may be enumerated as follows: In reflex arcs as compared with nerve trunks there is "(1) slower speed as measured by the latent period between application of stimulus and appearance of end effect, this difference being greater for weak stimuli than strong; (2) . . . marked 'after discharge'; (3) less close correspondence between rhythm of stimulus and rhythm of end effect" (each reflex has its own characteristic rhythm which it maintains under any adequate stimulus); "(4) less close correspondence between the grading of intensity of the stimulus and the grading of intensity of the end effect; (5) considerable resistance to passage of a single nerve impulse, but a resistance easily forced by a succession of impulses (temporal summation); (6) irreversibility of direction instead of reversibility as in nerve trunks; (7) fatigability in contrast with the comparative unfatigability of nerve trunks; (8) much greater variability of the threshold value of stimulus than in nerve trunks; (9) refractory period, 'bahnung,' inhibition and shock, in degrees unknown for nerve trunks; (10) much greater dependence on blood circulation, oxygen . . .; (11) much greater susceptibility to various drugs—anesthetics" (p. 14).

These characteristics of reflex conduction are investigated in great detail and variety of conditions in order to determine what part of the mechanism of the reflex arc is their immediate seat. It is evident from the fact that the white matter of the nervous system consists in nerve trunks that the seat of the characteristics peculiar to reflex arcs must be found in the gray matter, and since reflex arcs always consist in at least three neurones, it is at once suggested that the synapses may be the mechanism in question. Much strong evidence is adduced to confirm this suggestion, and the author agrees with W. McDougall in attaching to the synapse primary importance in the physiology of the nervous system.

The method of the organization of reflexes into simultaneous and successive combinations so as to bring about complex actions extended both spatially and serially, is determined by comprehensive and detailed experiments. The important structure in the combination of reflexes is the 'common path,' especially the 'final common path.' In the common path stimuli from diverse parts of the organism, if allied, cooperate in bringing about the reaction, and if antagonistic they compete for the use of the 'effector,' with the result that one is effective and the other is inoperative. The common path, then, is the means of coordinating the various reflexes, and it is at its synapse that the phenomena of summation, 'bahnung,' interference, inhibition, etc., take place.

The author then traces the process by which the cerebrum acquires dominance over the rest of the nervous system. In the course of development the leading segment of a plurisegmental animal becomes highly differentiated and becomes possessed of receptors of a high degree of sensitivity. These receptors, the eye, ear and olfactory organ, become sensitive to stimuli from distant objects, and are therefore called 'distance receptors.' These receptors enormously increase the range of the animal's adaptation to its environment. Since their reactions require the activity of the whole organism, the other, more partial reflexes become mere appendages. The brain as the 'ganglion' of the distance receptors becomes in the higher animals, then, the dominant part of the nervous system, and in man, 'reason,' based on the power of associative recall, becomes the supreme guide to conduct.

In the last lecture[1] the author takes up a problem which has direct psychological bearing, *viz.*, the problem of 'sensual fusion.' Nervous integration has been seen to take place through the fusion of nervous impulses in the same 'final common path.' The question is whether the sensory elements which are related in the sense percept are fused primarily for the percept, or whether the sensations are first elaborated and then fused in the percept secondarily. "To what extent is the visual singleness (in the case of binocular fusion) due to a direct confluence of the sensory paths?"

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[1] This lecture appeared originally in the *British Journal of Psychology*, Vol. I., Pt. I.

The question was investigated by the determination of flicker thresholds in binocular fusion of coincident and alternating stimuli, in comparison with the fusion of like stimuli in a single eye. It was found that the light phases in one eye (so far as sensual effect goes) do not interfere nor combine with coincident dark phases of the other, or, to put it in another way, stimulations of alternate right and left arrangement do not combine as series of additive stimuli as would be the case if there were confluence of the sensory fibers before the elaboration of the sensation.

A change in the frequency of one component altered the common threshold to a point between the extremes of the separate thresholds. This process may be taken to be analogous to that by which the brightness resulting from the synchronous stimulation of the two eyes by lights of different degrees of brightness is not the sum of both, but is near the arithmetical mean between them. Both processes are referable to perceptual rather than sensory fusion. The phenomena of the predominance of contours in binocular and uniocular fusion point to the same conclusion.

The anatomical fact that the fibers from the same side of each retina (afferent fibers from 'corresponding points') are projected on the same occipital cortex, which seems to present a difficulty to this view, is explained upon consideration of the other fact that stimulations of corresponding points of the two retinæ require conjugate movement of the two eyes to bring the point on the foveæ. It is therefore natural that fibers from corresponding points should meet in the same 'final common path.' This explanation is supported by the fact that stimulation of a point in the visual cortex of the occipital region does cause conjugate movement of the two eyes in the opposite direction. The fusion of sensations in a perception, then, is seen to be parallel to, if not incidental to, the fusion of afferent arcs in the 'final common path' to bring about the motor reaction.

It is evident that the whole trend of the book, though it is primarily physiological, is a strong argument for some sort of 'motor theory' of consciousness. In the first place, as the culmination in the psychological discussion of the last chapter indicates, physiology has immediate significance for psychology, and *vice versa*. In fact, the author himself says, at the opening of the last lecture, that the brain must be considered primarily as the organ of mentality, and therefore can not be fully investigated from the purely physiological point of view; and in closing the lecture he says: "It is around the cerebrum [which he has called the organ of mentality], its physiological attributes, that the main interest of biology must ultimately turn."

It follows, then, from the treatment of the total reflex as the fundamental unit instead of the afferent or the efferent part of the arc, and the treatment of the simultaneous and successive integrations of the nervous system as centered about the *relation between the afferent and efferent impulse* at the 'final common path,' that there is strong presumption that conscious development is similarly centered about the whole receptive-motor process, and not about one abstract element of it. This position receives strong confirmation from the experiment on binocular fusion in perception.

The book is accompanied by an exhaustive bibliography, and the author supports each step in his argument by frequent reference to his own extensive and minute experiments as well as to the results found by other investigators. Numerous reproductions of myograph curves, etc., illustrate the text.

The original lectures which are reproduced in this volume were delivered at Yale University as the Silliman Memorial Lectures for 1904.

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Some Important Situations and their Attitudes. A. H. LLOYD. *Psychological Review,* January, 1907. Pp. 37-53.

'The situation' in general is the fact of conflict, specific situations involving specific concrete conflicts. Conflict may be stated in various ways, as, the opposition of an existing structure to its environment, the struggle of the personal or variable in man against the habitual, the war of second nature against first nature. The resolving of the conflict takes place through four principal moments. First, there is the *moral situation,* in which existing human habits or laws are confronted by some emergency to which they are not adequate. This induces the *ethical attitude,* which is, in effect, respect for abstract law. "Lawfulness . . . rather than the specific law or structure, is the concern of the ethical attitude." Clinging to the human law, man is set over against nature and regards nature with blind fear. The second moment is the *artistic situation,* which induces the *esthetic attitude.* In the esthetic attitude man no longer feels himself opposed to nature, but in truce with nature. He becomes rather an observer, and the conflict would seem to be now between two different elements in nature, the man being more withdrawn from active participation. His emotion is now one of awe instead of fear. The third moment is the *practical situation* inducing the cognitional or *reflective attitude.* In this attitude man, instead of blindly fearing nature, turns upon her a speculative eye. What before he opposed he now impersonally examines. The reflective attitude fulfills itself in, fourth, the *natural situation.* Here we find nature overwhelming the human structural element which opposed her. "The reflective attitude is always an invitation to nature to realize herself." In this realization of nature the old human habits and laws are broken down and reorganized into a new structure. The attitude corresponding to this final solution of conflict is called the *spiritual,* volitional or religious. In it the personal and the natural are reconciled, and the human being recognizes nature in himself.

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